Application of Random Probability Surveys to Assess Mercury Contamination and Biological Attainment in Northeastern Waters

Neil C. Kamman
Vermont Department
of Environmental Conservation

Planning a Survey of the Nation's Lakes
Chicago, Illinois
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The main theme of this discussion

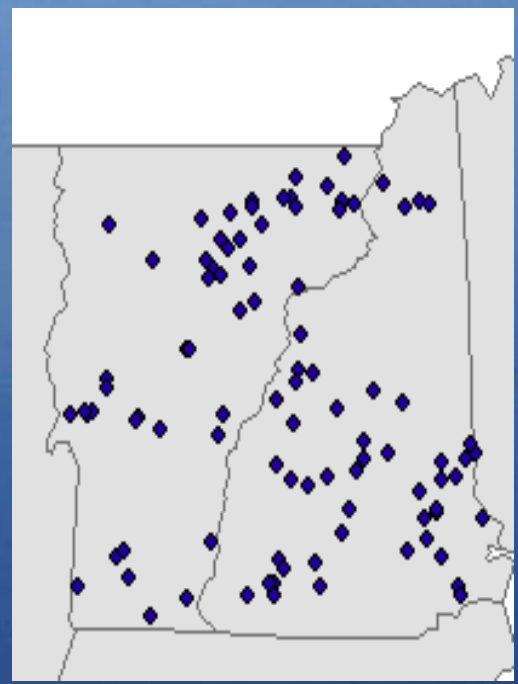
- Vermont's experience implementing probability surveys is limited.
- Vermont's experience using information derived from probability surveys is pretty good.
- The utility of probability survey results is scale-dependent.

Details of the discussion

- Probability surveys and mercury contamination in VT and the Northeast.
- Probability surveys and biological attainment in VT, the NE, and the US.
- Forthcoming planned surveys in the Northeast.

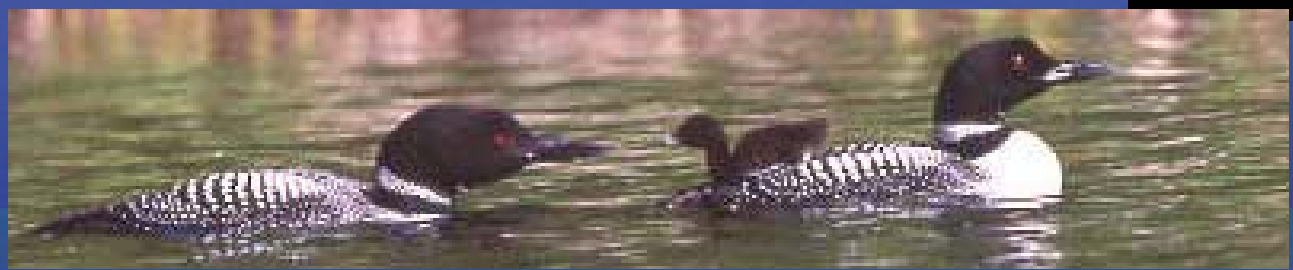
The VT-NH REMAP Project

- Initiated in 1998 to assess mercury contamination patterns in lakes
- One of two probability-based, multi-media assessments of air deposition, water, sediment, and biota mercury contamination
- 90-lake survey, ≥20 ac
- Draw carried out by U. S. EPA Corvallis lab
- Weighting balanced VT, NH
- Reported on 2004 305(b)

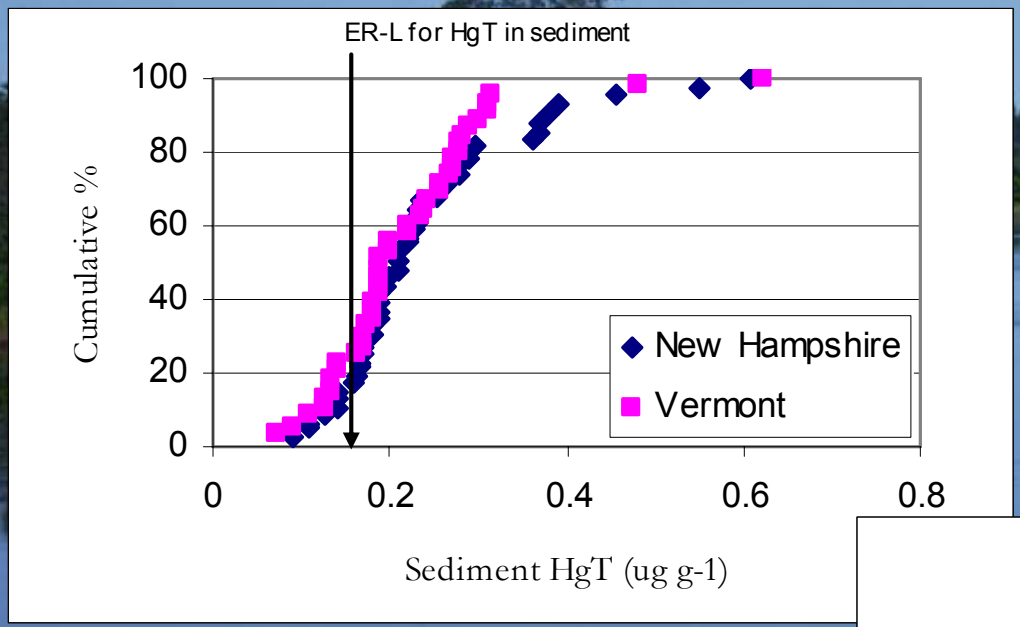


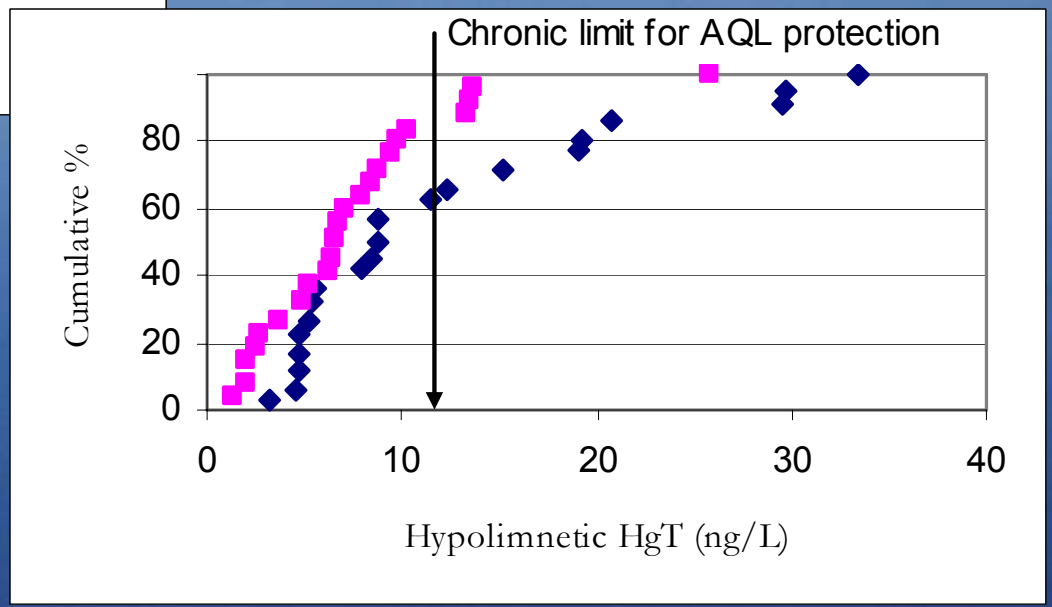
The VT-NH REMAP Project

- Hg and meHg in epi and hypolimnetic water
- Hg and meHg in sediments
- Hg and meHg in prey-sized YLP
- Hg in YLP fillets
- Hg in piscivorous birds



Distributions in relation to thresholds





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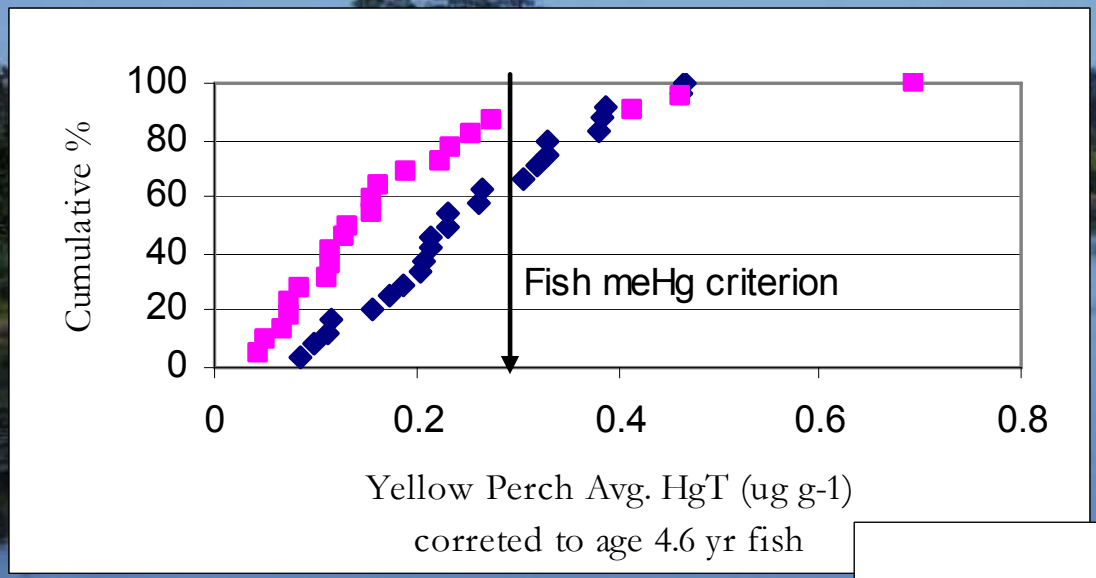
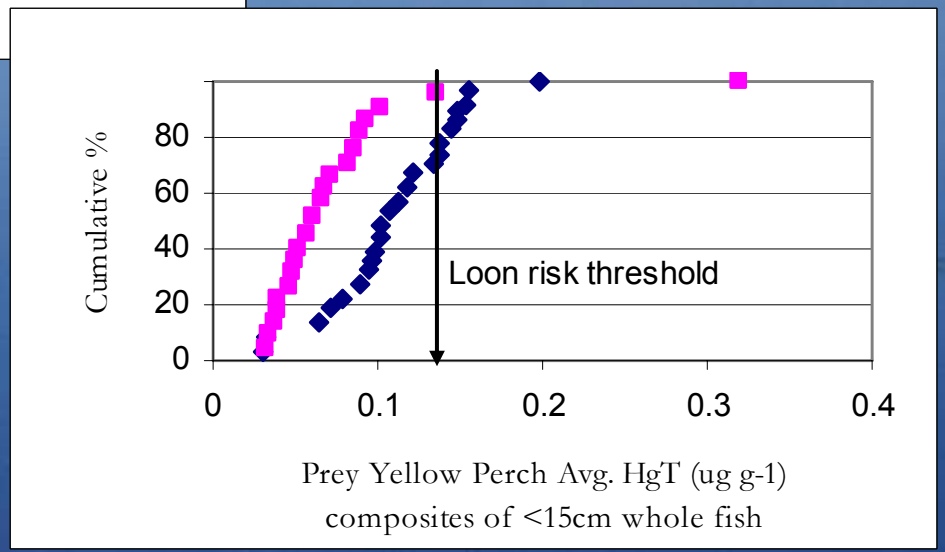




Modeling compliance with tissue criterion

Yellow perch fillets <0.3 ug g^{-1} HgT, Meets EPA Criterion:

-1,580 – 82.92(lnANC) + 45.35(lnDOC) + 1,658(ln_pH) - 18.99(lnCond) – 35.09(invrtFlush) Eq. 1.

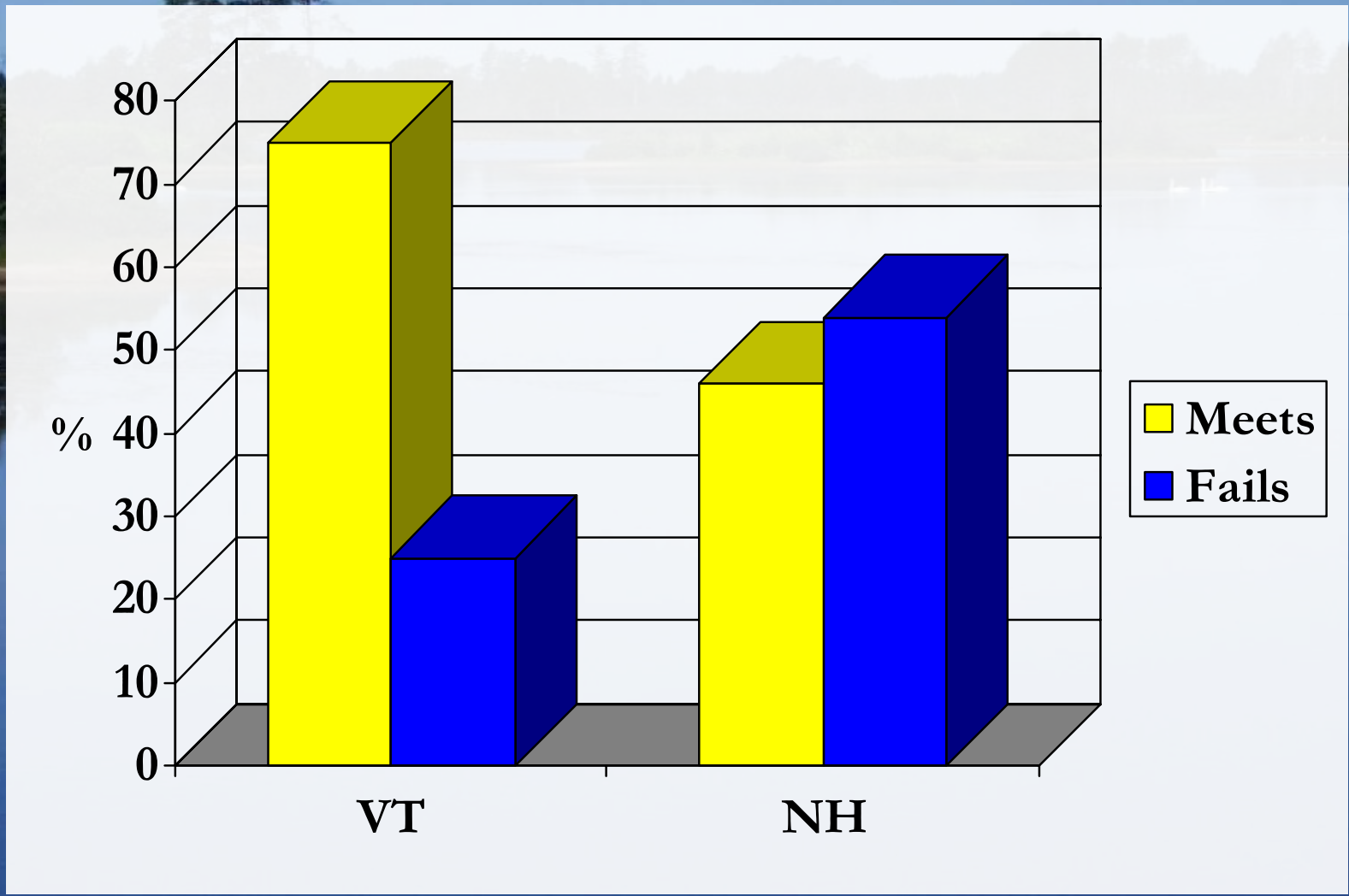
Yellow perch fillets >0.3 ug g^{-1} HgT, Violates EPA Criterion:

-1,494 – 81.94(lnANC) + 48.49(lnDOC) + 1,610(ln_pH) – 18.65(lnCond) – 33.02(invrtFlush) Eq. 2.

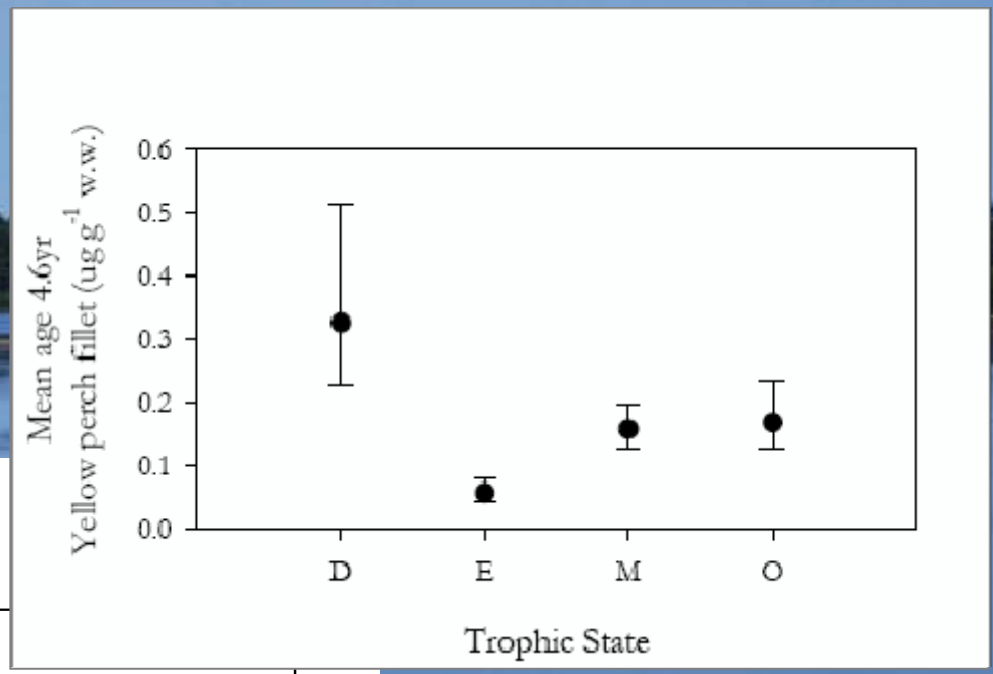
Where:

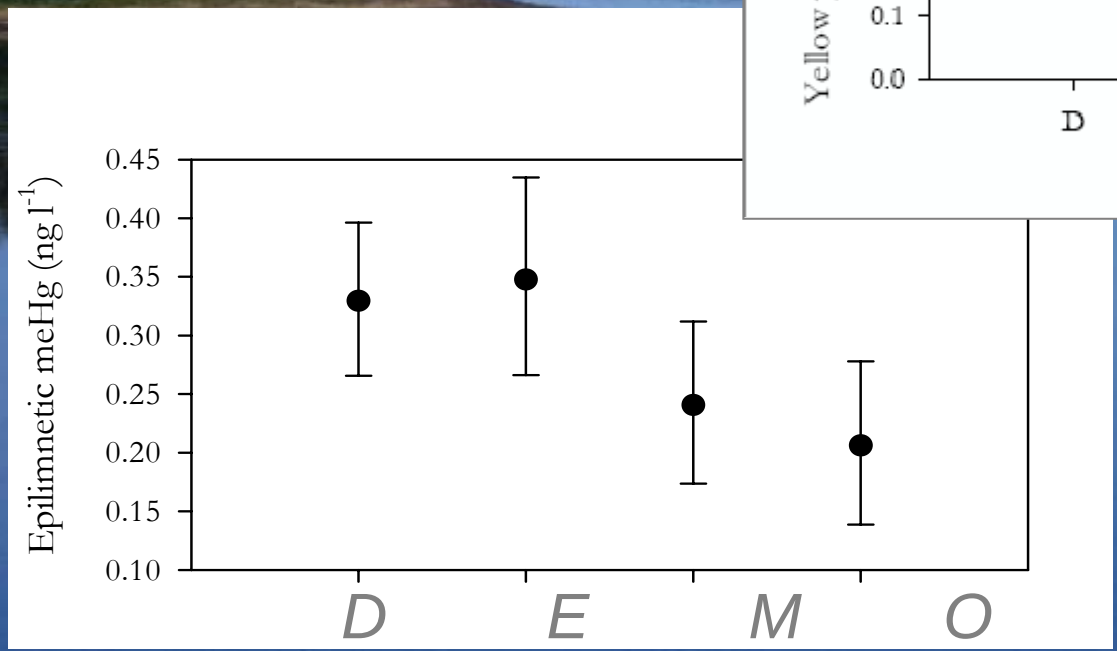
lnANC = ln (1+acid neutralizing capacity, in mg l^{-1}, measured from the epilimnion)
lnDOC = ln (1+dissolved organic carbon, in mg l^{-1}, measured from the epilimnion)
ln_pH = ln (1+pH, in standard units, average of total water column)
lnCond = ln (1+conductivity, in us cm^3, average of total water column)
invrtFlush = (Flushing rate, in # yr^{-1})$^{-2}$

Modeling compliance with tissue criterion

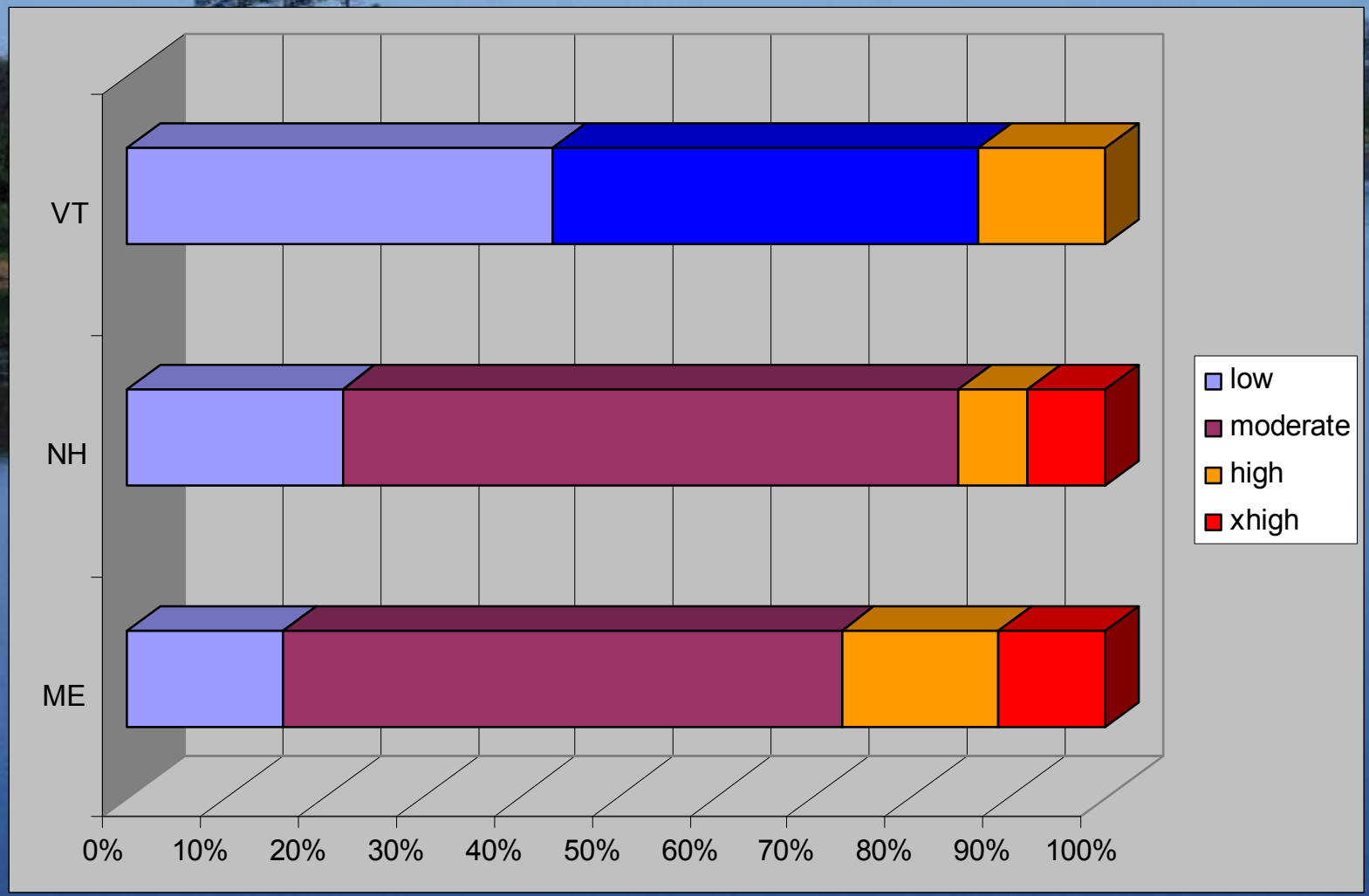


Bloom Hg dilution

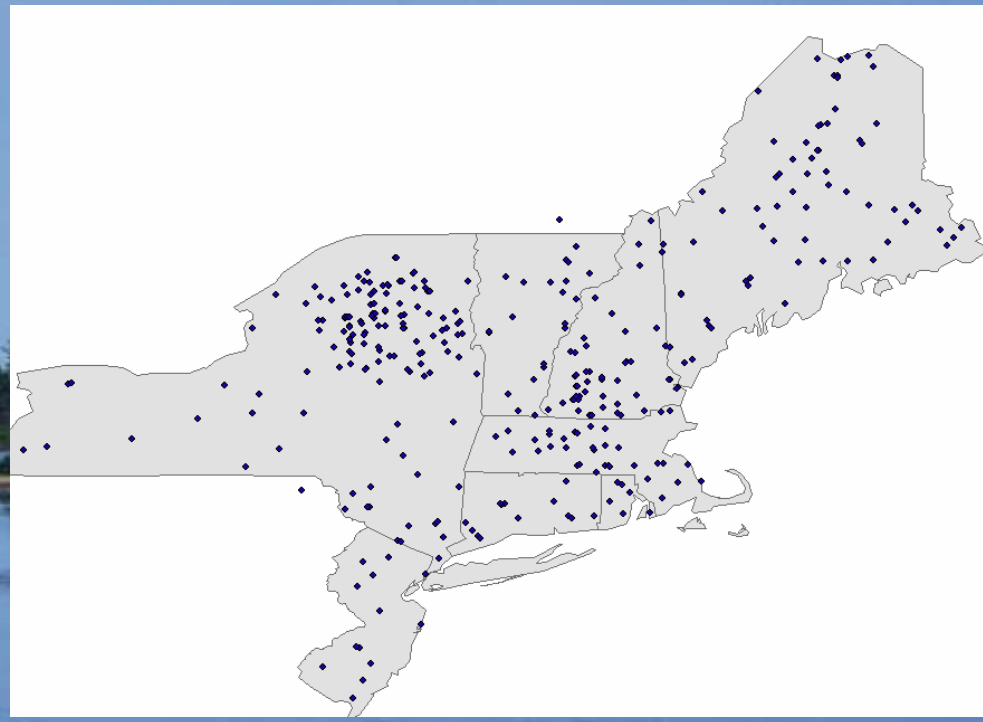




Combining VT-NH and Maine REMAP Cumulative Risk Index based on Hg in Loon Blood



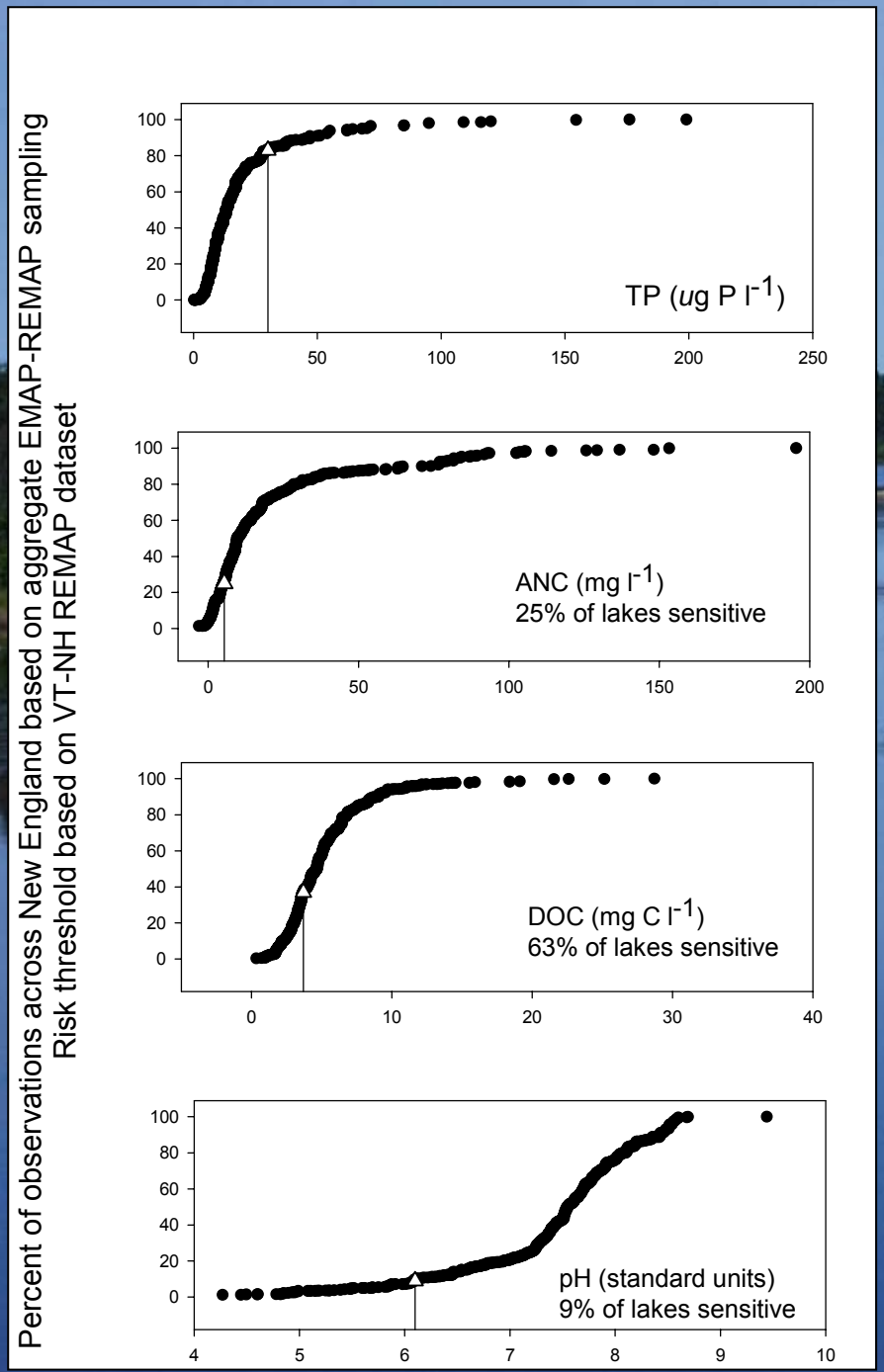
EMAP-NE Lakes 1990-1992

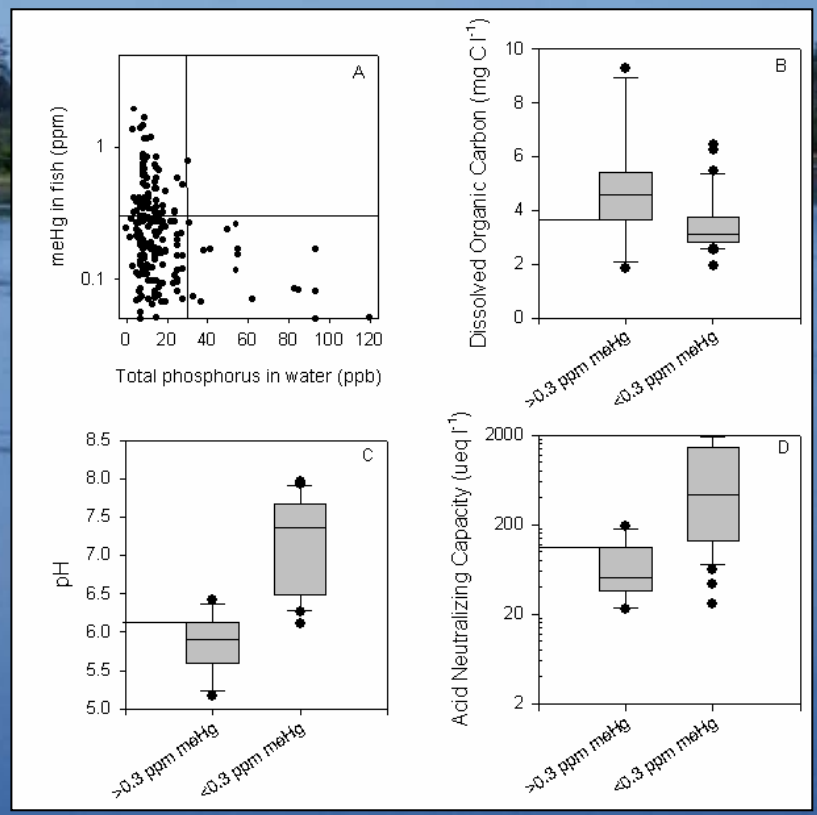


- Assessment of trophic state, and of trophic change using paleolimnology
- Initial highlight on fish contaminants
- Assessment of zooplankton community responses to disturbance
- Dataset provided “jump-off” point for many research-based projects with wide and varied applicability.
- EMAP-NE has proved a gold mine to the mercury research community

Data synthesis

"NERC" and "HBRF" initiatives





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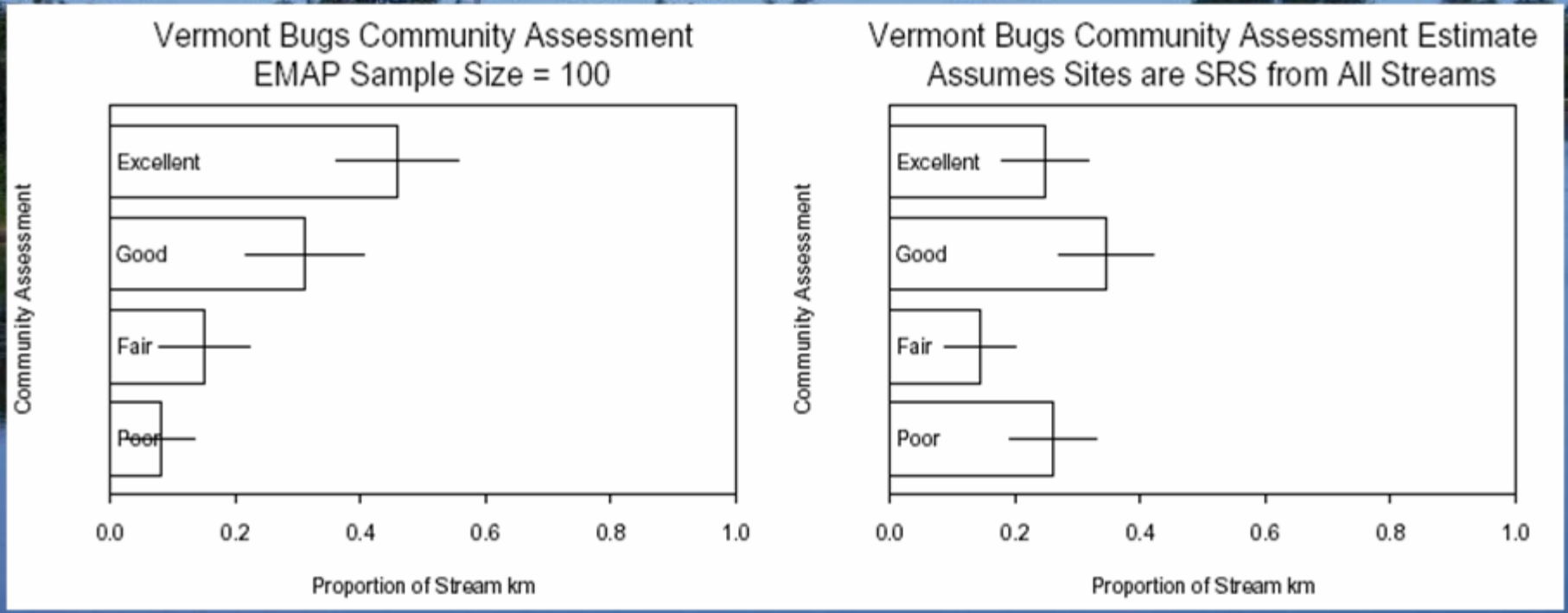
Cumulative results of the Northeastern probability studies

- Maine study established the first Northeastern fish consumption advisory
- EMAP regional study provided a rich data source for identifying mechanisms of Hg bioaccumulation
- VT-NH study verified several mechanisms, and provided a model by which lakes could be assessed for sensitivity to mercury bioaccumulation
- HBRF synthesis laced probability survey findings together into a definitive statement on the footprint of mercury as an environmental contaminant in the Northeast

Assessing biotic integrity for all VT streams - a hybrid approach

- Initial attempt to develop a randomized assessment of ALUS for streams using existing data from non-probability sites
- VTDEC ambient biomonitoring network comprises 1,674 sampling locations
- Narragansett Laboratory provided a draw of 301 sites based on the NHD.
- Sites overlaid onto VT map, and closest existing ABN sites was identified.
- Site assessment findings were catalogued and reported on 2002 305(b) report

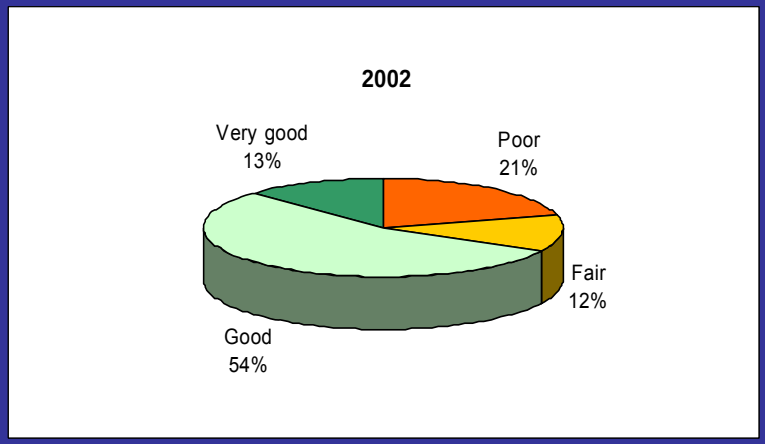
ABN sites vs. probability site assessments



New England Wadeable Streams (NEWS)

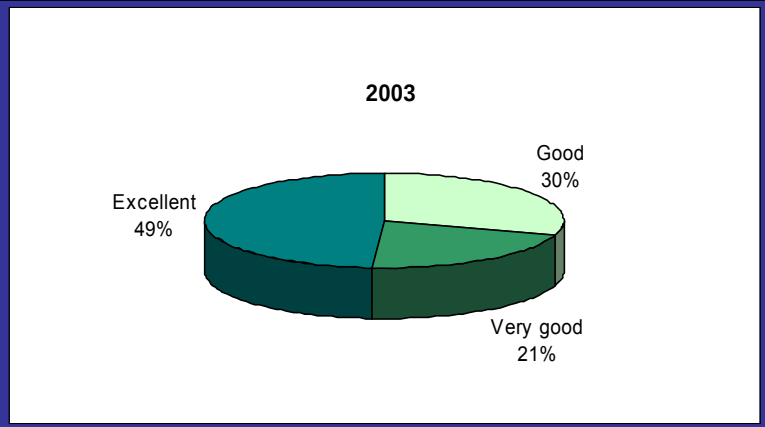
- Regional initiative to assess ALUS across N.E. states with a 60-site regional draw over 50-site nested state draws
- Merged a multi-habitat macroinvertebrate and habitat assessment method developed by EPA Region 1 with state-specific assessment protocols
- Yielded a huge dataset with thousands of macroinvertebrate counts, derived from several methods. Executed over a four-year period
- VT's approach to NEWS was to incorporate probability sites into rotational basin assessments

Mix of agricultural, urban & forested areas.



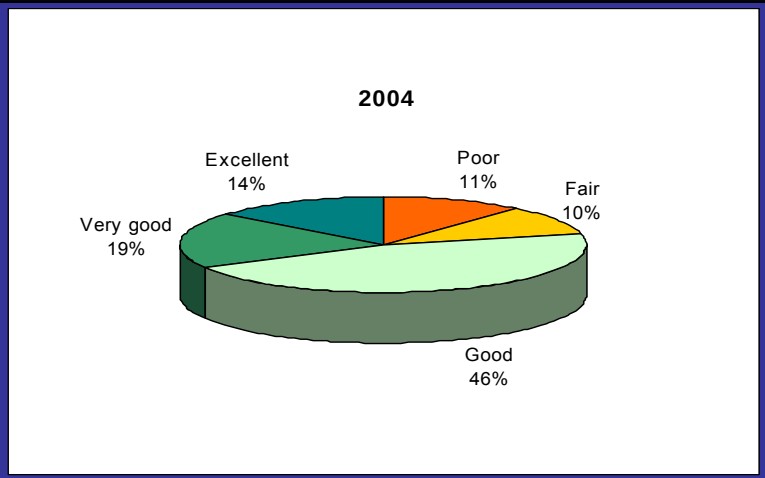
2002

Mostly forested with scattered urban areas.



2003

Mix of agricultural, urban & forested areas.



2004

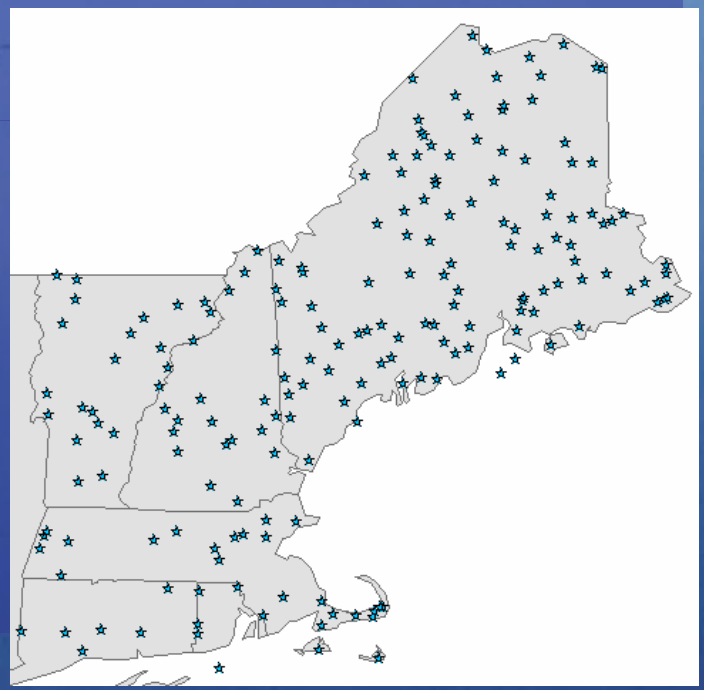
National Wadeable Streams (NWS)

- VT has also participated in the National Wadeable Streams project
- In N.E., NWS overlaid NEWS sites
- State of NH recently recalibrated the WSA assessment results to a set of independently-derived reference sites, yielding a statewide stream ALUS assessment for their 2006 305(b).
- VT is considering a similar analysis

New England Lakes and Ponds Project (NELAP)

- 300 lakes across region
- Random selection stratified on lake size
- Selection weighting adjusted to permit an even number of lakes amongst States (~50)
  - e.g., it is a collection of state “draws” within a regional “draw”

- Designed in collaboration with New England state lake managers and academic experts.
- Project begins in four weeks.



NELAP-Modules

- Water chemistry/multiprobe profile
- Sediment chemistry and paleolimnology
- Zooplankton size distributions and cataloguing by automated flow-cytometry
- Rapid fish Hg testing by biopsy-plug and pyrolysis-CVAA analysis
- Standardized littoral habitat assessment
- In-situ hyperspectral imaging
- Technology-based data management

VT lessons to date

- VT has only implemented two self-directed random-probability surveys to date
  - VT-NH REMAP
  - NEWS (by basin)
- These projects have yielded useful statewide assessments, and transferable models and findings.
- These smaller-scale projects yield more detailed results that are useful for resource management.

VT lessons to date

- VT has participated in or used data from larger surveys to important effect.
- Publicity associated with the synthesis of mercury information from 2005 precipitated legislative and policy action at the state and regional level, and prompted policy discussions at the national level.
- The larger-scale surveys assist states in assessments to a degree, but their greater utility is in the potential to provide policy-driving results.

What's next in VT

- New England Lakes and Ponds Project
- National Lakes Assessment
- Application of a new VT-specific lake IBI to these random probability survey lakes
- Discussions with Narragansett laboratory to investigate alternatives to the "hexagon-overlay" approach to permit random probability surveys independent of design weight considerations

Neil Kamman
Vermont Department of
Environmental Conservation

(802) 241-3795

neil.kamman@state.vt.us